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Water infrastructure and the making of financial subjects.
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Water Infrastructure and the Making of Financial Subjects in the South East of England

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ABSTRACT: Over the last four decades the locus of economic power has shifted from industry to finance. As part of this trend, the 'financialisation' of the water sector has added a new layer of complexity to the hydrosocial cycle, witnessed in the emergence of new financial actors, logics and financing instruments. Such a shift has profoundly reshaped the relationship between water utilities and consumers in the South East of England, where the household has become, in the words of Allen and Pryke (2013), a human revenue stream for financialised utilities. In this paper, we make an argument that the water meter is one of the crucial mediators through which finance will touch the lives of individual subjects. In the South East of England, after initial opposition to universal metering – in part shaped by fears over fluctuating revenues – water companies are now embedding a metering programme within a billing and tariff structure that aims to ensure governable and predictable subjects. Drawing on Urban Political Ecology, we argue that the financialisation of the water sector in England shapes the emergence of new financial subjectivities while enabling new forms of political rule that operate at a range of spatial scales.

KEYWORDS: Water meters, financialisation, hydrosocial cycle, households, South East England

INTRODUCTION

If privatisation debates dominated discussions around water governance throughout the late twentieth century, provoking analyses of the relationship between political economic change and the deregulation and reregulation of the water sector (Bakker, 2003), a fundamental shift is now apparent. Financial actors now exert a profound influence on water governance, and the model that has evolved is far removed from the shareholder capitalism around which privatisation originally cohered (Allen and Pryke, 2013; Merme et al., 2014). As several authors now recognise, the 'financialisation' of the water sector has added a new layer of complexity to the hydrosocial cycle,¹ witnessed in the emergence of new financial actors, logics, and financing instruments (Bayliss, 2014, 2015; March and Purcell, 2014). In parallel, there has been a resurgence of major infrastructure projects (Loftus and March, 2016); the

¹ We take this term from Linton and Budds (2014), among others, who emphasise the socio-natural processes through which 'society' and 'nature' make and remake one another. Importantly the term emphasises a range of political and social considerations shaping what is often considered a nonsocial *hydrologic* cycle.

sector has become much more heavily indebted; and as part of a 'twin track' approach, several utilities in the South East of England are embarking on a range of different metering programmes. These compulsory metering schemes imply both threats and opportunities to financialised utilities. On the one hand, stable returns generated through charging households fixed rates for water are threatened by the likelihood of bills fluctuating according to varying consumption. Nevertheless, if utilities can be protected from short-term volatility in the early years of meter adoption, these metering technologies provide opportunities for companies to access far more data on household consumption and, crucially, if embedded within a new system of billing, they provide the opportunity for companies to exert greater influence over consumer behaviour, thereby better matching stable revenues with future demand predictions. If Allen and Pryke (2013) are correct to argue that the household has become a human revenue stream within the financialised water sector, it is no longer appropriate for this revenue stream to behave in erratic and unpredictable ways. Instead, governable, responsible subjects are required. For many of the water utilities operating in England shifts in consumption patterns could contribute to wild swings in the water service provider's credit ratings. Thus, in this paper we argue that the financialisation of the water sector increasingly relies on predictable and governable behaviour at the household level and on the emergence of new subjectivities in relation to the disciplining technology of the water meter and new billing practices.

Urban Political Ecology (UPE) is situated in a privileged position for shedding light upon the changes wrought by financialisation through its focus on the choreographies of power within the water sector, as well as its focus on finance's intermingling with large infrastructures and micro-infrastructures at the household level. Similarly, water supply in England provides us with an optimal case through which to demonstrate such changes. While some years ago England and Wales were together viewed as one of the iconic examples of outright divestiture within the water sector, the English case² now allows us to scrutinise the deep entanglements of financialisation with the hydrosocial cycle. Thus, we draw on UPE in order to make sense of the relationship between the emergence of new financial subjectivities in the water sector and the political rule of finance.

The paper is therefore structured as follows. After this brief introduction, we seek to explain why UPE is particularly well placed to be able to make sense of the most recent changes within the hydrosocial cycle, especially in considering the entrance of new financial actors, instruments, and logics. Afterwards, we present an extended review of up-to-date work on the financialisation of the water sector before dealing with the specific case of South East England in order to develop our argument further. Finally, we conclude with some reflections on the importance of considering financialisation within critical research on water service provision, infrastructural form, and political rule.

URBAN POLITICAL ECOLOGY AND FINANCE

Since its inception, UPE has engaged with the politics of infrastructural provision. Instead of posing a set of merely technical questions, in which infrastructure appears as an unquestioned or unproblematic backdrop, urban political ecologists have analysed the political achievements of urban infrastructural projects (Kaika, 2005). Water infrastructure is shaped by, and shapes, broader cultural, political and economic sets of relations (Gandy, 2002). In so doing, UPE has engaged with many of the debates that frame this special issue. Thus, Swyngedouw (2015) has addressed the Wittfogelian legacy directly, while others have drawn from Graham and Marvin's (2001) work on *Splintering Urbanism* to better

² We do not consider the Welsh case, given the fact that almost all water provision in Wales was taken over by a not-for-profit entity in 2001. Nevertheless, as Zetland (2016) demonstrates, the high customer satisfaction rates of Dwr Cymru/Welsh Water, and the entity's very different approach to metering could provide an important contrast to the trends we cite in this paper. We do not consider the Scottish and Northern Irish cases, as these have a different governance system.

understand the connections between infrastructure and shifting forms of rule. In order to focus attention on the contribution of UPE to theorising forms of political rule, we will briefly consider the overall approach.

UPE is non-canonical. Made up of a diverse set of approaches, its influences are various, its inspirations many, and it is perhaps best conceived of as a terrain of debate. For Heynen et al. (2006), along with many of the contributors to their definitive volume of essays, key influences on their own approach to UPE can be found within Smith's (1984) quixotic thesis on the production of nature. Against "bourgeois ideologies", in which nature is framed as simultaneously universal and external to human life, Smith traces an alternative tradition in Marx, thereby claiming that nature is better understood as "produced", first as use value, and then, with encroaching capitalist social relations, as an exchange value (ibid.). This latter phase in the production of nature marks the entry and circulation of a second nature within the web of life (cf Moore, 2015). The production of nature thesis was a crucial step in Smith's reinterpretation of the production of space (and its connection to the survival of capitalism), as well as to his understanding of uneven development on both an urban and a global scale. For Swyngedouw (1995) the production of nature thesis opens up an understanding of the city as neither entirely social nor entirely natural. Analysing the urbanisation of nature thereby demands an approach that is attendant to questions of hybridity and that can be captured effectively through the figure of the cyborg. Inspiring a range of subsequent research projects, UPE's focus on cyborg urbanisation has enabled scholars to address questions of techno natures (White and Wilbert, 2006), the phantasmagoria of urban technological networks (Kaika and Swyngedouw, 2000), and the reification of urban infrastructure provision (Loftus, 2006). Kaika (2005), moreover, has deployed Benjamin's notion of the 'wish image', alongside Marx's understanding of commodity fetishism, to emphasise the neglected power exerted by urban infrastructures over the populations they are assumed to serve.

Although some urban political ecological works have turned to the question of financialisation (March and Purcell, 2014; Loftus and March, 2016), this putative shift in capitalist social relations remains relatively underexplored when one considers the growing importance of financial actors in the provision of a range of services from electricity to water, waste, sewerage and transportation. Nevertheless, we would argue that UPE lays the foundations from which a powerful analysis of financialised water infrastructure and its internal relationship to forms of political rule might begin to emerge.

First, UPE has been deeply attentive to the changing political economy of water provision through linking a critique of political economy to changing forms of political rule and emergent subjectivities. Thus, Swyngedouw (2004) makes the provocative claim that the privatisation of water involves the transformation of local waters into global money. Furthermore, this transformation involves an act of dispossessing populations from their means of existence (Swyngedouw, 2005). For Loftus (2012) new technologies become necessary in ensuring that accumulation by dispossession can be reproduced as an ongoing process, even in a context (South Africa) in which a constitutional guarantee of the right to water appears to undermine such a process. A range of metering technologies therefore proliferated in South Africa following the dramatic commercialisation of bulk water provision in the wake of the 'achievement' of the right to water. Water metering in this instance becomes a 'necessary' measure for protecting the fragile revenues of eThekweni Water Services and its commercialised bulk water provider, Umgeni Water. For Nash (2013), the enrolment of consumers as participants in the act of achieving full cost recovery – in part through ensuring a new role for water meters – represents a scaled form of passive revolution (cf. Morton, 2007). In England and Wales, Drakeford (1998) shows how prepayment meters became a widespread technology used by the newly privatised water companies in order to ensure revenues were protected. And Bakker (2003) embeds this 'revenue protection', and its

subsequent overturning, in a broader understanding of the de-regulation and re-regulation of the water sector in England and Wales.

Second, UPE, drawing from Harvey's (1982) landmark analysis of the spatio-temporalities of capital accumulation, has drawn attention to what Ekers and Prudham (2015) refer to as "fixed capital accumulation... as the physical congealment of accumulated ecologies and histories" alongside "an extended geography of resource flows that represent the materials that enter and exit the production process". Beneath the relative fixity of most infrastructural networks, urban political ecologists have been sensitive to the shifting historical geographies of capital accumulation which always suggest that permanence may only be relative. The financialisation of infrastructure can thereby be analysed through the changing composition of capital in a given moment and the forms of political rule that have sought to foster and enable such a shift (Loftus and March, 2015). An analysis predicated on such principles forms the basis for the approach taken forward in March and Purcell (2014) where the uneven geographies of financialisation are analysed across a range of different water providers, albeit with a primary focus on Aguas de Barcelona. In short, urban political ecologists have developed an approach that is geared towards understanding the changing makeup of water infrastructure in relation to the changing composition of capital as a social relation.

Third, UPE has analysed the manner in which shifts in infrastructure provision are intimately tied to the development of distinct subjectivities. For Loftus and Lumsden (2008) Durban's experiments in trisector partnerships, through which the private sector has worked with both NGOs and the municipal provider, are part of an attempt to cultivate a new form of responsible consumer who will enable more stable revenues to be captured. A purported 'culture of nonpayment' becomes the central obstacle to the smooth running of a commercialised service provider. Elsewhere, Hellberg (2014) has looked at the emerging biopolitical effects of water provision in Durban, thereby linking the emergence of neoliberal subjectivities to differentiated access to water, mediated through a variety of technological shifts. And Nash (2013) has emphasised the manner in which participatory processes enable consumers to be enrolled in the neoliberalisation of water. The various studies of Durban echo O'Reilly and Dhanju's (2014) findings that subjectivities – in O'Reilly's work (see also O'Reilly, 2006) gendered and caste-based subjectivities – become central to cost recovery principles in Rajasthan, India. In both cases, neoliberal authority comes to be exercised through new subjectivities that are engendered by the intersection of forms of rule and infrastructural arrangements.

Exploring the emergence of these distinct subjectivities Ekers and Loftus (2008) draw on the tensions and resonances between Foucauldian and Gramscian approaches, claiming that the two thinkers provide insights into how dispersed forms of rule operate within and through the water network. If Foucauldian perspectives have been numerous – in particular through governmentality and biopolitical arguments (see Bakker, 2011) – Gramscian approaches have, more recently, gained some purchase in thinking through the relationship between infrastructural form and the nature of political rule (Loftus and Lumsden, 2008; Nash, 2013; Akhter, 2015). Gramsci appears particularly well suited to an UPE approach because of his nuanced development of a philosophy of praxis. Repeatedly insisting on the 'earthliness of thought' Gramsci's approach builds on Marx's *Theses on Feuerbach* to analyse the fusion of theory and practice. The simple (or often not so simple) act of ensuring a household has access to safe, sufficient supplies of drinking water places individuals in an active – and sensuous – relationship with socio-natures. Conceptions of the world emerge from, and are shaped by, this practical sensuous activity. For Gramsci, such conceptions are one moment within the sedimented and contradictory worldviews that constitute 'common sense'. Overlaid with scientific, religious and folkloric worldviews, common sense always contains a kernel of good sense from which an immanent critique might be possible. Thus, although ideology can be consolidated in a person's material activity and his/her relations with forms of infrastructure, the possibility for critique is embedded within the very same praxis. More recently, Rehmann (2013) has placed Gramsci's philosophy of praxis at the

centre of a wide-ranging survey of ideology. At the heart of Rehmann's approach is a sensitivity to the concrete acts through which individuals produce and reproduce their conditions of existence. We would argue that such an approach should be central to an analysis of the relation between new forms of infrastructure, the process of financialisation, and the emergence of distinct financial subjectivities. First, however, it is important to gain a deeper understanding of the changes implied by the term financialisation.

FINANCIALISATION OF THE WATER SECTOR

The concept of financialisation has received considerable attention from critical political economists and economic geographers in recent years [see, for instance, the work of Langley (2003, 2008); Aalbers (2008, 2015); Hall (2012) or Christophers (2013, 2014, 2015)]. Definitions vary considerably (as signalled in the range identified by Lee et al., 2009); indeed financialisation risks achieving the status of a buzzword (Christophers, 2015), including a variegated group of processes, or what Murphy (2015) characterises as "financialisation unlimited". Ouma (2015: 228) therefore calls for the debunking of the term: "so let's get in between M and M' [referring to the lending out of money (M) for interest (M')] – potentially without financialisation – and make finance political in different ways". Whether the concept of financialisation is too broad, has been used too loosely [and therefore "hollowed out" (Ouma 2015: 225)], or whether it has, perhaps, lost its explanatory power (Christophers, 2015) is not the focus of this paper. Indeed we agree with Murphy (2015) that if the concept of neoliberalism implies variegated strategies, so this is also the case for financialisation. In our view, the term does have some validity. Indeed, over the past few decades there has been a shift in the locus of economic power, which has encouraged a much more speculative form of capitalism that is reliant on rent extraction and less obviously reliant on the creation of surplus value within the real economy (Harvey 1989, 2005; Foster, 2007; Lapavistas, 2014). The range of actors involved, and the interests shaping the provision of a range of necessities from healthcare services to water have been profoundly altered.

A growing body of work has therefore embarked on analysing the interlinkages between finance and the environment (see Liverman, 2004; Robertson, 2011; Castree and Christophers, 2015; Galaz et al., 2015; Loftus and March, 2015), and its increasingly critical role in environmental governance, as well as the production of historically and geographically specific natures (Labban, 2010; Sullivan, 2013; March and Purcell, 2014). This body of work underscores the complex and contradictory relations between something so material as 'nature' and the fictitiousness of the speculative claims being made in nature's name (see Labban, 2010). Knox-Hayes (2013) sees the financialisation of nature as a form of time-space compression, which intensifies a divorce between the use value of resources and the exchange value of financial instruments; this divorce, in turn, threatens the material integrity of natural ecosystems. In any case, the argument is that nature and the environment may influence financialisation, but, at the same time, financialisation shapes the production of nature. Among other dimensions, scholarship has focused so far on finance and climate, including fictitious commodities such as CO₂ (Pellizzoni, 2011; Lohman, 2012; Knox-Hayes, 2013) and weather derivatives (Pike and Pollard, 2010); agriculture (Bracking, 2012; Ouma, 2014); timberland (Gunnore and Gellert, 2011); energy (Fusaro and Vasey, 2006; Labban, 2010); nature conservation (Brockington and Duffy, 2010; Sullivan, 2013); or green grabbing³ (Fairhead et al., 2012).

In what is referred to as the hydrosocial cycle, we can observe the creation of a complex of water-related financial products and instruments in the past few years, ranging from water-targeted investment funds; to structured water products within major investment banks; water indexes; or

³ Fairhead et al. (2012:237) refer to green grabbing as "the appropriation of land and resources for environmental ends".

exchange traded funds (Bayliss, 2014, 2015). In England, the ownership of companies is increasingly in the hands of financial investors. The dominant ownership model in the water sector has evolved from holding groups listed on the stock exchange (privatisation to mid-1990s), to multinational ownership models (mid-1990s until 2000), to a situation where over half of the industry is now owned by private equity consortia (Tinson and Kenway, 2013: 6; see also March and Purcell, 2014). Ownership titles are traded following financial market indicators that are delinked from the real economy. At the global level, the prioritisation of shareholder value has had a clear impact on their geographical expansion and retrenchment through recent investment decisions (March and Purcell, 2014). Indeed, as Bayliss (2014: 300) notes, "water investments have become transformed into assets that can be disposed of during difficult times". Water services – as opposed to water itself – therefore become tradable assets. And, as is argued elsewhere (Loftus and March, 2015), this process is enabled through the specific forms of infrastructure provision.

If the financialisation of water has been enabled through infrastructure, over the last decade infrastructure has simultaneously become one of the essential sites for absorbing over-accumulated capital within the global economy (Harvey, 1982; Torrance, 2009). Such spatiotemporal fixes make it imperative to focus on the financialisation of infrastructure. In the immediate wake of the financial crisis, clearly recognising that investment strategies had been highly speculative and overly risky, Ouma notes (2014: 63) (quoting the investor Jim Rogers) that "what was suddenly in demand was less 'financial engineering' and more 'real things'". Finance's new love affair with real things – with built infrastructure and land – therefore comes at a time when, by 2030, around US\$60-70 trillion will be needed to develop additional infrastructure (in general) capacity at the global level (Alexander, 2015). Some argue that, although public investment could cover US\$30-35 trillion of this financial need, and private investment a further US\$ 10-15 trillion, the remaining gap of US\$15-20 trillion will need to be covered by institutional investors (Alexander, 2015). Along these lines O'Brien and Pike (2015) argue that austerity and fiscal constraints, combined with pervading systems of financialisation, have redefined urban infrastructure as a new asset class. Traditional sources of infrastructure financing are under stress, as the OECD (Della Croce and Yermo, 2013) recognises, and new institutional investors, such as pension funds or institutional investors, have emerged as key actors (Clark, 2001). In the case of the UK those actors have been rescaled and, in the process, have returned to risky, speculative, complex and expensive investment arrangements in urban infrastructure (notwithstanding the apparent move away from risk in the turn to 'real things'). There has simultaneously been a wider reconfiguration in that cities may source new private capital for urban development and infrastructure investment. Infrastructures are thus thought to generate long-term inflation-protected returns. Nevertheless, in the past few years there has been an emergence of innovative funding mechanisms for infrastructure systems, predicated upon future growth and revenue: a shift from grant-based mechanisms towards investment-type infrastructure projects consisting of loan-based revolving or recycled funds (O'Brien and Pike, 2015). UK cities have thereby been encouraged to "flirt with risky, complex and potentially more expensive investment activity". For Torrance (2008) this shift points to the apparently contradictory scalar tendencies within financialised infrastructure, relying as it does on a model of glocal governance in which financial instruments become increasingly globalised, at the same time as returns are increasingly dependent on local regulatory mechanisms.

Far from being an abstract concern that merely affects shareholders, financialisation has therefore had a major impact on large infrastructural developments (Merme et al., 2014), profoundly influencing infrastructural developments within the hydrosocial cycle, among them, for instance, Thames Water's desalination plant in London (Loftus and March, 2016). Financialisation of the hydrosocial cycle has, furthermore, expanded towards the household, as Allen and Pryke (2013: 419) have documented in the case of Thames Water, underscoring the manner in which this model is geared towards providing benefits to investors rather than providing for consumers' needs. Water infrastructure is thus what enables "the trickle-up of wealth to the richest through the consumption of water" (Bayliss, 2014: 295).

Crucially financialisation not only affects the supply-side infrastructure that provides water – providing substance to the claim that big infrastructure is back (Loftus and March, 2016) – it is also likely to have an influence on households through the forms of infrastructure and tariff mechanisms needed to generate steady returns. Indeed for several of the large water companies in the South East of England, water meters act as crucial mediators between large financialised infrastructure, the companies, and the final water user. In this sense, while in recent decades there has been an apparent shift away from supply-side strategies, based on the increase in water provision through large-infrastructure solutions (e.g. dams) towards a 'twin-track approach' including demand-side management options (see Stephenson, 1999) based on pricing (and universal metering), both supply-side and demand-side 'infrastructural fixes' coexist. Furthermore, both are now part of a broader web of financial engineering. Thus, while large infrastructural solutions are once again being rolled out [even dams have seen a resurgence under financialisation (Merme et al., 2014)] and a new hydraulic paradigm has been embarked upon in the form of desalination plants (March et al., 2014; March, 2015), at the same time, private companies and public water agencies have launched new demand-side strategies, such as universal metering programmes. Although these can be seen to have been part of a long-term plan on the part of both the regulator and the Conservative Party, it is only over the last decade that metering has really progressed. As we argue in the next section, which focuses on the specific case of the South East of England, the twin strategy of developing supply-side and demand-side infrastructures may not be as paradoxical as it might seem. Such an argument, nevertheless, needs to be positioned in relation to a financialisation process in which meters have become the crucial mediator between the political rule of finance and the emergence of new financial subjectivities in the home.

FINANCE, INFRASTRUCTURE, AND POLITICAL RULE

Although financial actors now play a central role in the provision of water in England, the sector remains tightly regulated, primarily by the economic regulator, Ofwat, whose duties are set out in statute (Water Industry Act, 1991; Bakker, 2003).⁴ Price limits are set every five years, following a price review process that is administered by Ofwat⁵ and that results in a situation where revenue streams are somewhat more predictable for a number of years (Bayliss, 2015). Predictability of revenues is increasingly important for companies, several of which are very highly geared⁶ (Tinson and Kenway, 2013) and, as such, are more exposed to risks associated with revenue volatility. In a move that would appear to pull companies in the opposite direction, however, companies are increasingly under pressure to reduce abstractions and to introduce strategies for managing household water demand, among them metering.

While household water metering is a common demand-management strategy in most other European countries, just one-third of households in England were charged for water and sewerage

⁴ The regulatory framework in England and Wales also includes: the Environment Agency which regulates water abstraction and advises government on any environmental consequences that result from company practices; the Drinking Water Inspectorate which sets drinking water standards; and the Consumer Council for Water, which is the statutory consumer body for the water sector. The Scottish water sector and the system in Northern Ireland are subject to separate legal and regulatory frameworks.

⁵ Price limits are set for a 5-year period but companies are permitted to increase bills by inflation; the sector uses the Retail Price Index (RPI).

⁶ By highly geared, we mean a high debt to equity ratio within the company. Again, this shift from equity to debt as a form of finance has been crucial to the process referred to as financialisation within the water sector.

according to a metered bill in 2009 (Walker, 2009: 31).⁷ Historically household water bills in England and Wales have been calculated using a proxy for property value,⁸ a strategy that provided water companies with regular and predictable flows of revenue. Although some companies experimented with forms of metering in the 1980s and 1990s (Drakeford, 1998), most companies have been reticent to make the case for introducing credit payment meters on a universal basis. This is due, in part, to the capital costs associated with a metering programme and in part to the increased risk of revenue volatility associated with households paying for water on a volumetric basis. At the same time, the perverse incentives of the regulatory regime seem to provide no reward to companies for introducing measures that might result in their customers using less water.

Nevertheless, growing household-demand for water, due to a combination of population growth and changes to the way water is used at home, has renewed the focus on demand-management strategies and ways to encourage households – that reportedly use 52% of the public water supply – to use less water (Defra, 2008: 19; 2011; Walker, 2009; Ofwat, 2011). Thus, in August 2007, the central government announced that companies operating in areas classified as seriously water-stressed could consider compulsory household metering as part of their long-term plans (Defra, 2007; see EA and Natural Resources Wales (2013) for more information about water stress classifications). Metering has become a crucial part of the dynamic in the South East of England, with three companies South East Water, Southern Water and Thames Water pursuing compulsory metering programmes (see table 1). Billing customers by volume rather than by the rateable values of properties, nevertheless, would appear to introduce far greater volatility within the stable revenue supply upon which financialised utilities depend.

Table 1. Metering programmes in the South East of England.

Company	Supply area	Meter penetration before commencement of compulsory metering programmes	Metering programme
Southern Water	One million customers across Sussex, Kent, Hampshire and Isle of Wight	Approximately 40%	Universal Metering Programme. 92% of households metered by 2015
South East Water (water only)	2.1 million customers across Kent, Sussex, Hampshire, Berkshire	Approximately 40%	Customer Metering Programme. 70% households metered by 2015, 90% by 2020
Thames Water	14 million customers across London and the Thames Valley	Approximately 30%	Progressive Metering, 56% of households metered by 2020, near universal metering by 2030

⁷ There is enormous regional variation in levels of meter penetration with much higher rates in the South West of England where water prices have been significantly higher than the rest of country; prior to 2009, Folkestone and Dover (a water only company) had embarked on a small-scale compulsory metering programme.

⁸ The rateable charging system was introduced in 1847 to fund large-scale sanitation improvements. The rateable value system contained a form of inbuilt cross-subsidy where those in more expensive homes paid higher bills. Rateable values were last updated in 1973, and new homes built between 1973 and 1990 were assigned a rateable value. This particular proxy for property value is not used to inform charging systems for any other services (Walker, 2009: 31).

The contradictory requirements of a stable revenue stream and the need to expand metering programmes can be contextualised within the political economy of water governance in the present moment. Although the Byzantine corporate arrangements of an entity like Thames Water makes tracing the origins of profits particularly difficult, it is clear that predictable revenues from households are a crucial link in a complex web of relationships that includes sovereign wealth funds, pension funds and investment banks. In spite of the complex packaging of risk, at the base of the corporate structure is the household. Indeed the water sector remains effectively financed by customer bills (Bayliss, 2015). Unsurprisingly, households have seen their bills increase faster than inflation since privatisation. Although Ofwat has not granted above-inflation rises in each price review, Walker (2008), in her government commissioned review, accepts that there has been a 42% rise in water prices in real terms. More recently, water companies have seen their profits rise particularly quickly in those years when interest rates have been low and when inflation has been higher than Ofwat assumed during its price determination. Although Ofwat set clear price limits, companies' revenues can vary greatly from the forecast amount, which, in turn, can have a substantial influence on profits. Crucially, calculating bills by the volume of water used, rather than by a fixed price, introduces uncertainty and less predictable revenue streams. Revenue shortages are therefore particularly hazardous for the most highly geared companies and 'under-recovery' can have serious short-term impacts on corporate credit ratings. One stark example can be found in the case of Southern Water, the most highly geared company in the sector, whose debt was downgraded by Moody's credit rating agency to two notches above junk status in 2011. This was the lowest rating issued to any water and sewerage company since privatisation, reflecting lower-than-expected consumption levels and a subsequent revenue shortfall (Gray, 2011). Writing to Ofwat, Southern Water attributed some of the revenue shortfall to its Universal Metering Programme and a reduction in consumption associated with a period of drought (Southern Water, 2014).

Experiences such as those of Southern Water have been mitigated somewhat through OFWAT's introduction of a Revenue Correction Mechanism (RCM) in 2008. In a clear recognition of the potential risk to revenues through the introduction of metering programmes, the aims of the RCM are: to minimise the risks of a company under- or over-recovering revenue relative to the assumptions made when price limits were determined; and to remove the disincentive for a company to promote water efficiency (Ofwat, 2008: 65-66). The first year in which a metered bill is received represents the period of greatest uncertainty for both households and utilities alike. Moving from a fixed charge based on rateable value to a charge based partly on metered consumption can mean either an increase or a decrease in the bill charged to households (Walker, 2009).⁹ After this initial year, it becomes far easier to predict household responses to seasonal variance as well as overall consumption. In some respects, the RCM can be seen as a crucial step in ensuring short-term variability in revenues is compensated for, enabling water companies to move towards a longer-term approach based on data-gathering and an ability to influence consumer behaviour. The mechanism therefore allows companies to make a case to Ofwat for an increase in bills in order to compensate for under-recovery, while enabling a case to be brought to a company should it recover more revenue than anticipated. If metering may once have represented a challenge to the sustainability of highly geared water companies in the financialised water sector, the RCM means that short-term risks of revenue volatility associated with metering – that Southern Water and other companies were facing – can to some extent be reduced thereby allowing

⁹ It should be noted that each of the companies offers slightly different 'transitional' tariffs, where the proportion of the bill that reflects the volumetric tariff increases over a number of bill periods, sometimes years. The household initially receives a bill that includes an estimation of their bill on the full metered tariff. Households can choose to switch over to the metered tariff immediately or stay on the transitional tariff. Such transitional tariffs are a further mechanism through which companies avoid the uncertainty of charging through a metered system.

companies to continue to collect relatively stable revenues and, crucially, begin to build on a longer-term strategy of using meters to influence individual behaviours within the home.

In regard to this ability to influence individual behaviours, meters are important 'mediating technologies' (Marvin et al., 2011) and, depending on the configuration of the technology, can be used to restructure relationships between water users and utilities (Feenberg, 1999). Traditional "dumb" meters therefore enable companies to better secure the water network by more easily identifying leaks and tracking flows of water. However, buried in the ground outside of the home, these meters are largely invisible to households and have a limited influence on governing household behaviours. The meters that have been installed in the South East of England therefore boast additional functionalities and Thames, Southern and South Eastern have all opted for (slightly different) smart metering systems.

Smart meters or, as they are sometimes termed, Intelligent Metering systems permit more detailed, more frequent, and more accessible data to be made available to both consumers and companies. In a review of Intelligent Metering programmes within urban water delivery, Boyle et al. (2013) point to the potential of such devices for better understanding consumption trends and for reducing demand. Citing early evidence from trials in Sydney, they suggest that Intelligent Metering can lead to a 7-10% reduction in consumer demand over and above other types of metering. The evidence for demand reduction from metering programmes is somewhat mixed. The government-commissioned Walker Review suggested a 10-15% reduction in demand through water metering. Earlier National Metering Trials in England suggested a reduction in consumption of 11% (Gadbury and Hall, 1989), although Staddon (2008) calls the longevity of these reductions into question. Where Staddon (2008) does see evidence of meters reducing consumption is through improved leak detection and, importantly, a reduction in peak demand. This reduction in peak demand – with an arguably greater influence through Intelligent Meters (Boyle et al., 2013) – is in part a result of the disciplining of behaviour through the water meter itself. While seasonal variance remains by far the greatest influence on water demand, reducing peak demand and ensuring more accurate predictions of future demand are crucial to the water companies. The relationship with the consumer is transformed in the process. Thus, in a paper in this journal Zetland (2016: 126) argues that "Water meters transform water users from passive *consumers* taking what (RV-funded) services they are given into active *customers* entitled to value for money" (italics in original). Recognising the important critiques of social practice theorists (Medd and Shove, 2005), most would acknowledge the importance of contextual factors within such a transformation – societal understandings of "comfort, cleanliness and convenience" (Shove, 2003) are crucial, for example; but the important role of the water meter in mediating the shifting political economy of water provision is also now widely recognised (Marvin et al., 2011).

While enabling utilities to better track peak flow and more accurately model future demand (Parker and Wilby, 2013) intelligent metering also permits data to be shared more easily with consumers themselves, a crucial plank in the 'libertarian paternalism' that has given rise to nudge-style behavioural economics, inspired by Thaler and Sunstein (2009), and which has been increasingly influential in UK policy making in general (Jones et al., 2013). In the water sector nudge economics can be found most clearly in Ofwat's 2011 paper *Push, pull, nudge: how we can help customers save water, energy and money*, which explored a range of nudging techniques, many of which were to be facilitated by the meter itself. Here the financial value of water is emphasised in literature pertaining to metering, and companies try to create a greater sense of individual responsibility by urging households to take 'control' over their bill while altering the ways in which they use water.

One of the ways that companies are attempting to use smart(er) meters to nudge water use behaviours is by changing the appearance and the information contained within metered bills. For instance, metered bills display consumption patterns and tips on water savings while showing comparisons between the billed household's water use and that of other households, of a similar size, in the water company's service area. These bills are also colour-coded, with households receiving green

bills if consumption is within the usual threshold and purple if consumption exceeds that threshold. Thus, the meter enables greater feedback to be shared with households and a purple bill provides "immediate recognition, like a red bill does" (Utility Week, 2011: online). Companies have also run extensive public education and engagement programmes in the run-up to meter installation, creating online portals through which consumers can monitor their household water use. Some have included a mandatory water efficiency audit as a part of fulfilling eligibility criteria for hardship support. Moreover, when households receiving meters are part of a compulsory metering programme they can choose to move on to a measured tariff immediately or some companies also offer a 'transitional tariff' which gradually moves a household from an unmeasured to measured tariff over the course of several bill periods. This, according to the companies, provides households with an opportunity to adjust their behaviours to the recently installed meter and to experiment with water efficiency strategies; it also means that the companies can better understand the likely impacts of any changes in consumption on their revenue flows before metered charging takes full effect. Meters therefore play a mediating role in facilitating the emergence of new financial subjectivities within the home by communicating companies' attempts to produce more 'responsible consumers' in a way that minimises the risks of revenue volatility.

Although much of the writing on financial subjectivities (for a review, see Hall, 2012) has drawn attention to the new forms of risk-taking that are engendered within everyday life, it becomes clear from the above that the consumers of financialised services are also enrolled within the shifting political economy and governance arrangements implied by the term. Financialised infrastructure mediates these shifting arrangements and, for most households, provides a direct experience of the changes that come to be fetishised within what appears an unchanging infrastructural form (cf Kaika and Swyngendouw, 2000). Put more simply, residents of the South East of England are most likely to experience the financialisation of the tightly regulated water sector through their sensed and sensuous engagements with particular infrastructures. Although all of Thames Water's customers will soon experience a dramatic increase in bills through the construction of the Thames Tideway Tunnel (Smithers, 2015), which, it is worth noting, is likely to become one of the most iconic of financialised infrastructures in the UK, it is the sudden appearance of water meters within the home (after the intransigence of generations of water engineers in the UK towards developing such demand-side technologies (McCulloch, 2009)) that provides the most direct experience of financialisation. To paraphrase Thames Water's own advertising banner, it is the water meter that enables the utility to be "at the heart of everyday life". Thus, new subjectivities emerge in relation to the financialised water sector. Capillary power works to engender these new subjectivities through the infrastructure itself (for a much deeper discussion, which goes beyond the limits of this paper, see Nash, 2014).

Water infrastructure, the water meter, the bill, and 'the nudge' are crucial to the emergence of financial subjectivities. These financial subjectivities are not characterised by new risk-taking practices but, instead, by the disciplined or responsible behaviours necessary to ensure a continued revenue stream for the financialised entities that depend on them. For urban political ecologists this poses new questions that go beyond the fetishisation of the infrastructural form to consider: the historical and geographical specificity of financialised infrastructure; the relationship between financialisation and infrastructural form (cf Loftus and March, 2016); and the possibility for more democratic and egalitarian futures that might contest the political rule of finance. In relation to the first point, we have demonstrated that the enthusiasm for universal water metering now characteristic of water service providers in the South East of England suggests that there is something historically and geographically specific about the emergence of water metering. Secondly, the form of that infrastructure shifts, in part because of the financial needs of the water service providers. This changing form is, in part, necessary in order to better shape the kinds of behaviours on which those entities rely – above all predictable consumption patterns over the longer term. If there is to be a challenge to this political rule by finance within the water sector, one starting point might be returning to the water infrastructure and the

practices through which that political rule is mediated. Indeed the immanent critique implied within Antonio Gramsci's reading of common sense suggests that better understanding such practices – how individuals within households make sense of themselves in relation to the changing practices of acquiring and paying for water within a financialised sector – might provide fertile conditions of possibility for critical understandings of financialisation. Here, just as the subjects of the abstract world of clock time occasionally rebel against their alarm clocks, so the financial subjects being disciplined by the water meter may find new ways of struggling against their reduction to abstracted financial subjectivities.

CONCLUSION

Although it is more conventional to consider the relationship between water infrastructure and political rule through the grand engineering projects that have transformed watersheds (Worster, 1985), generated immense symbolic power for political leaders (Kaika, 2005), and woven new political alliances within what is often a fragmented set of interests over the appropriate uses of water (Swyngedouw, 2015), it is no less important to understand how infrastructure touches the lives of subjects through the intimacies of the home (Kaika, 2005). Social practice theorists have therefore sought to demonstrate how behaviours develop always in relation to forms of infrastructure. Subjectivities are engendered through their quotidian practices that bring networks or assemblages into being. For urban political ecologists there are clear political implications to such a claim. Thus, changing infrastructures within the home are implicated in the emergence of forms of political rule. New subjectivities are engendered and contested in relation to such changes.

In England and Wales, as several authors have now noted, a profound shift has occurred in the manner in which water companies operate. This differs greatly from the model of privatisation initially embarked on in the 1980s (Allen and Pryke, 2013: 420). Heavily leveraged entities now dominate the sector. Indeed

the monopoly nature of water provision and the captive income streams involved have the potential to deliver known rates of return over fixed time periods for investors, in agreement with the regulator, Ofwat. For an increasing number of highly leveraged water companies, of which Thames Water is probably the leading exemplar, such revenue streams are viewed more as financial assets, which, through processes like securitisation, are capable of generating funds that appear to have little connection to the operational side of the business and, we [Allen and Pryke] would argue, have more to do with a redistribution of value that favours investors over customer households.

Nevertheless, if the operational side of the business appears to have a diminishing role in these newly financialised entities, captive income streams and known rates of return also depend on households acting in particular ways – consuming a known amount of water, and being receptive to being nudged into habits and practices that are more likely to provide the steady returns needed. The apparent shift in attitudes of water utilities' to metering technologies appears to have been guided in part by the need to ensure such behaviours are fostered. Furthermore, these practices cannot be divorced from the particular conceptions of the world that emerge in relation to the water sector. Building on a philosophy of praxis, we have called for a focus not on political rule as it is established "on the level of consciousness" but on the "functioning of ideological powers, apparatuses, practices and thought-forms" (Rehman, 2013: 11). Financialised infrastructure that enters into the intimacies of the home assists in the transformation of the household into a human revenue stream and, at the same time, serves to discipline behaviours, shape practices, and foster new thought forms associated with the political rule of finance. Nevertheless, within such a framework we see the unceasing possibility for forms of resistance to develop. The entry of financialised infrastructure into the home suggests as much the possibility for critique as it does the possibility of a dominating and dominant form of rule to be

established. Thus, an Urban Political Ecology attendant to the shifting forms of infrastructure in a new moment of financialisation might learn from the common sense understandings that emerge, translate and resist the political rule of finance. In so doing, an immanent critique emerges that provides a slightly more hopeful set of possibilities.

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